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I, LEANNE MYNOTT, MANAGER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003901793 for a patent by THOMAS ANTHONY MEYERS as filed on 15 April 2003.

WITNESS my hand this
Twenty-eighth day of November 2003

LEANNE MYNOTT
MANAGER EXAMINATION SUPPORT
AND SALES

P/00/009
Regulation 3.2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: "IMPROVEMENTS IN EXCAVATOR TEETH"

The invention is described in the following statement:

TITLE

"IMPROVEMENTS IN EXCAVATOR TEETH"

FIELD OF THE INVENTION

This invention is concerned with improvements in excavator teeth for earth excavating devices.

The invention is concerned particularly, although not exclusively, with the mounting of excavator teeth adaptors to adaptor noses on an excavating device such as an excavator bucket or the like.

BACKGROUND OF THE INVENTION

Excavating teeth mounted to the digging edge of excavator buckets and the like generally comprise a replaceable digging point, an adaptor body and an adaptor nose which is secured by welding or the like to the digging edge of a bucket or the like. The adaptor has a socket-like recess at its rear end to receivably locate a front spigot portion of the adaptor nose and a locking pin extends through aligned apertures in the adaptor and nose to retain the adaptor in position.

In use, excavator teeth are subjected to extensive load forces along a longitudinal axis of a tooth as well as in vertical and transverse directions. A snug fit is required between the digging point and the front portion of the adaptor and also between the adaptor socket and the nose spigot portion and their respective mounting pins to avoid premature wear between the components. As the various components wear, the locking pins can loosen thereby increasing the risk of loss of a digging point or an entire digging tooth assembly.

The greatest loads experienced by excavator teeth are vertical loads which tend to generate large moment forces capable of rotating a tooth off the front of an adaptor and/or rotating the adaptor off the adaptor nose.

Despite many prior art attempts to improve the mounting of an adaptor to a nose, most of these proposals suffer from one or more deficiencies.

United States Patent No 4,182,058 describes an excavator tooth having a rearwardly divergent tapering socket to receive a nose having a complementary-shaped front spigot portion. Resistance to rotational moment forces is borne by a resilient steel cotter pin extending through aligned vertical apertures in the socket and spigot portions.

United States Patent No 3,023,521 also describes an excavator tooth having a rearwardly divergent tapering socket to receive a complementary-shaped tooth support spigot portion. Rotational moment forces are resisted by a lip engaging in a recess in the tooth support member.

United States Patents 3,774,324, 4,338,736, 4,481,728 and 4,903,420 all describe nose and tooth combinations wherein the nose has a generally convergently tapering spigot portion with a forward tip having a box-like configuration with at least the upper and lower surfaces thereof having faces parallel to each other and to a longitudinal axis of the nose portion. With the exception of Patent No 4,338,736, which describes a transverse locking pin, each of the tooth mounting arrangements is heavily reliant on a large vertical locking pin to resist rotational moment forces

tending to rotate the teeth off respective noses.

United States Patent No 4,231,173 describes a tapered adaptor nose having a box-like free end, which engages in a mating box-like socket cavity to resist rotational moments. Opposed pairs of rearwardly extending tongues engage in corresponding recesses in the outer surfaces of the adaptor nose to resist rotational movements. Because the tongues themselves are unsupported, they possess a limited capacity to resist rotational moment forces.

United States Patent No 5,272,824 describes a structure similar to that of United States Patent No 4,231,173 except that the side tongues are of more robust dimensions and the upper and lower tongues are formed as box-like members with apertures to receive a vertical mounting pin passing through aligned apertures in the tooth and adaptor nose.

United States Patents 3,196,956 and 4,404,760 provide flat rail surfaces on the adaptor nose to engage with mating grooves in the socket aperture of a corresponding tooth. In the case of Patent No 3,196,956, the mating rail and groove surfaces are forwardly tapered, whereas in Patent No 4,404,760 the mating rail and groove surfaces are generally parallel to the longitudinal axis of a tooth.

United States Patent No 5,423,138 describes a generally tapered nose having a box-like front end with upper and lower transverse surfaces generally parallel to a longitudinal axis of a tooth. The parallel upper and lower transverse surfaces are contiguous with upper and lower rail surfaces on each side of the nose and parallel to the longitudinal axis of the

tooth. A pair of rearwardly extending side tongues locate in recesses formed in the outer side faces of the nose, ostensibly to resist rotational moment forces in the tooth. Because the side tongues are recessed to accommodate the side rail portions, the robustness of the side tongues is somewhat compromised.

United States Patent No 4,233,761 describes a fairly stubby tapered nose having a box-like front portion with upper and lower surfaces generally parallel to a longitudinal axis of an excavator tooth, an intermediate rearwardly diverging tapered portion and a rear portion having upper and lower surfaces extending generally parallel to a longitudinal axis of the tooth. Formed on the upper and lower surfaces of the front, intermediate and rear portions of the nose are spaced parallel reinforcing ribs which are located in mating grooves in the excavator tooth. A large vertical locking pin extends through aligned apertures in the tooth and nose between the reinforcing ribs. This structure is heavily reliant on the locking pin to resist rotational moment forces however it is considered that this configuration may be prone to failure in the rear portion of the adaptor.

United States Patent No 5,709,043 describes a nose/adaptor combination wherein the adaptor socket tapers convergently towards a box-like front portion having upper and lower bearing surfaces generally parallel to a longitudinal axis of the tooth, a front transverse upright bearing surface and rearwardly divergent bearing surfaces formed at obtuse angles between the converging upper and lower walls and the side walls of the socket, ostensibly to avoid areas of stress concentration.

United States Patent No 5,937,550 describes a lock assembly for releasably securing an adaptor to a nose of an excavator support structure. The lock assembly comprises a body and a base coupled together and adapted for insertion, while coupled together, in a hole in the nose of the support structure. The length of the lock assembly is extended to secure the adaptor and is retracted to release the adaptor. While adequate for securing an adaptor to a nose of an excavator support structure, the lock described in this patent is relatively complex in design and operation leading to high costs and labour intensive extraction procedures in the field.

While generally satisfactory for their intended purpose, the abovementioned prior art adaptor/nose combinations all suffer from one or more shortcomings or disadvantages in terms of inadequate resistance to rotation of an adaptor off a nose under the influence of vertical loads applying a rotational moment to the adaptor, a predisposition to premature wear, difficulties in retention of the adaptors on noses, inadequate locking systems and unduly complicated configurations giving rise to increased fabrication costs.

It is an aim of the present invention to overcome or alleviate at least some of the abovementioned prior art disadvantages or otherwise to provide consumers with a convenient choice.

SUMMARY OF THE INVENTION

According to one aspect of the invention there is provided an excavator tooth system comprising:-

a mounting nose having a projecting spigot; and,

a wear member having at one end th reof a socket, said socket being defined by spaced side walls and upper and lower walls converging from a rearwardly facing socket opening to a forward end of said socket, each of said upper and lower walls comprising a forward bearing face and a rear bearing face separated by a forwardly convergent intermediate face, said front and rear bearing faces being substantially parallel to a longitudinal axis of said wear member.

Suitably, said forward end of said socket forms an end bearing face.

If required, said end bearing face may extend transversely of said longitudinal axis.

The wear member may comprise an excavator tooth having a digging edge at a front end thereof.

Preferably, the wear member comprises an adaptor having a front end adapted for releasable attachment of a digging point.

Suitably, said wear member includes an aperture in at least one wall of said socket.

Preferably, said wear member includes aligned apertures on opposite walls of said socket.

If required, said aligned apertures may extend through upper and lower socket walls.

Preferably, said aligned apertures extend through opposite side walls of said socket.

If required, at least portion of said rear bearing face is of a

width greater than said forward bearing face.

At least portion of said rear bearing face may be of substantially a similar width to said forward bearing face.

Suitably, said rear bearing face is of an area greater than said forward bearing face.

The socket opening may have a transverse width greater than the width of the forward end of said socket.

If required, the side walls of said socket may taper convergently towards said forward end of said sockets.

Alternatively, the side walls of said socket may be stepped.

According to another aspect of the invention there is provided an excavation device having an excavator tooth system according to a first aspect of the invention and wherein said mounting nose is integrally formed with said excavation device.

Alternatively, said mounting nose may be attached to said excavation device.

According to a further aspect of the invention there is provided a lip for an excavation device said lip having a plurality of spaced mounting noses for excavator tooth systems according to a first aspect of the invention.

Suitably, said mounting noses are attached to said lip.

Preferably, said mounting noses are integrally formed with said lip.

If required, said lip may include wear plates releasably secured

between adjacent mounting nos s.

According to a further aspect of this invention there is provided a lock for releasably attaching a wear member to a mounting nose of an excavator bucket, said lock comprising:-

a retaining member having a head portion and a screw threaded shaft; and

an elongate body member having a non-circular cross section, said body member being adapted for removable insertion in a lock aperture of complementary cross section in the mounting nose, said body member including a screw threaded aperture to receivably locate said retaining member, said body member, in use, being captively retained in said lock aperture by a partial misalignment between said lock aperture and a retaining aperture in the wear member when said wear member is located on said mounting nose, said retaining member, in use, being releasably securable in said body member via said retaining aperture whereby said head portion is located within said retaining aperture to prevent disengagement between said mounting nose and said wear member.

Suitably, said head portion includes a tapered shoulder extending between said head portion and said shaft, said tapered shoulder in use being frictionally engagable with a corresponding tapered recess in said body member.

Suitably, said screw threaded aperture is displaced from the central longitudinal axis of said body member.

If required, said lock may comprises a corrosion resistant

coating.

Optionally, said body member may be formed from a corrosion resistant material.

Optionally, said body member may be formed from a rigid engineering plastics material.

The plastics material may be selected from nylon, glass filled nylon, or the like.

Optionally, retaining members are coupled with said body member at opposite ends thereof to secure the wear member on the mounting nose.

According to yet a further aspect of this invention there is provided a method of securing a wear member to a mounting nose of an excavator bucket including:-

inserting a body member of a lock into a lock aperture in said mounting nose, said body member having a non-circular cross sectional shape for location in a lock aperture of complementary cross sectional shape in the mounting nose;

captively retaining said body member in said lock aperture by locating a wear member on the mounting nose whereby a retaining aperture in the wear member is partially misaligned with said lock aperture in the mounting nose; and

inserting, via said retaining aperture, a screw threaded shaft of a retaining member into a screw threaded socket in said body member whereby a head portion of said retaining member is located in said retaining aperture to prevent disengagement between said mounting nose and said

wear m mber.

Optionally, retaining members are coupled with said body member at opposite ends thereof to secure the wear member on the mounting nose.

According to yet a further aspect of this invention there is provided a system for releasably retaining a wear member to a mounting nose of an excavator bucket comprising:

(a) a mounting nose having a non-circular lock aperture extending at least partially within;

(b) a wear member having at least one retaining aperture which is partially misaligned with the lock aperture in the mounting nose when said wear member is located thereon;

(c) a lock having a retaining member with a head portion and a screw threaded shaft; and a body member having a non-circular cross sectional shape adapted for removable insertion in said lock aperture in the mounting nose, said body member having a screw threaded aperture to receivably locate said screw threaded shaft, wherein in use, said body member is captively retained within said lock aperture by partial misalignment of the lock aperture and the retaining aperture when the wear member is located on the mounting nose and said screw threaded shaft is securable within said screw threaded aperture via said retaining aperture to locate said head portion within said retaining aperture to prevent disengagement between said mounting nose and said wear member.

Suitably, said screw threaded aperture is displaced from the central longitudinal axis of said body member.

Optionally, retaining members are coupled with said body member at opposite ends thereof to secure the wear member on the mounting nose.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be more fully understood and put into practical effect, reference will now be made to the accompanying drawings in which:-

FIG. 1 shows portion of an adaptor nose;

FIG. 2 shows an exploded view of an excavator tooth system according to one aspect of the invention.

FIG. 3 shows schematically an upright cross-sectional view showing the engagement between a mounting nose and an adaptor according to the invention.

FIG. 4 shows in transverse cross-section a locking pin for releasable attachment of the adaptor to the mounting nose;

FIG. 5 shows in transverse cross-section the locking pin of FIG. 4 in a locked position;

FIG. 6 shows schematically a transverse cross-sectional view of an excavator tooth system according to one aspect of the invention;

FIG. 7 shows a lip for an excavation device in accordance with another aspect of the invention;

FIG. 8 shows an exploded view of the lip of FIG. 7 and excavator teeth systems according to one aspect of the invention;

FIG. 9 shows the arrangement of FIG. 8 in an assembled state;

FIG. 10 shows a lock for releasable attachment of the adaptor

to the mounting nose;

FIG 11 shows a longitudinal cross sectional view of a retaining member of the lock of FIG 10; and

FIG 12 shows a longitudinal cross sectional view of a body member of the lock of FIG 10.

DETAILED DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, for the sake of clarity, like reference numerals are employed for like features where appropriate.

In FIG. 1, the mounting nose 1 is shown as integrally formed with a cutting lip 2 of an excavation device such as a dragline bucket or the like (not shown).

Nose 1 includes a pair of opposed generally parallel side faces 3, a front face 4 and upper and lower faces 5,6 converging towards front face 4. Upper and lower faces 5, 6 each include rear bearing faces 7 and forward bearing faces 8 separated by a tapered generally planar intermediate face 9. Rear bearing faces 7, forward bearing faces 8 and front bearing faces 10 are all shown as shaded regions for the sake of clarity.

Rear bearing faces 7 are parallel to each other as are forward bearing faces 8. Each of rear and forward bearing faces 7,8 are also parallel to a longitudinal axis X of the mounting nose 1.

Extending transversely of mounting nose 1 is an adaptor mounting aperture 11. Aperture 11 is generally oval in cross-sectional shape with the longer oval axis extending generally parallel to nose axis X. Aperture 11 is positioned closer to top face 5 than bottom face 4, the purpose of which

positioning will be described in detail later.

In a conventional tapered wedge-shaped adaptor nose there is a substantial rotational moment to a digging point in the region of the adaptor tip. This rotational moment force is resisted by normally directed forces in the rear of the upper and lower wedge faces and frictional forces in the upper wedge face. If the rotational moment is small compared with the normally directed forces on the upper wedge face, the frictional forces produced by the normally directed forces can be sufficient to withstand the rotational moment. For a digging point this usually is the case because as the moment force on the digging point is applied almost directly above the upper face of the wedge, the moments are small compared to the normal forces and the corresponding frictional forces are sufficient to retain the digging point in place.

In the case of the mounting between a wedge-shaped adaptor nose and the adaptor itself, the frictional forces are insufficient to withstand the rotational moment to prevent the adaptor from simply rotating off the nose under load. To overcome this it is customary with wedge-shaped adaptor noses to employ a substantial pin to retain the adaptor in place as the pin must withstand very large forces applied thereto. Typically, this necessitates a vertically oriented pin.

In the present invention, the key bearing faces are configured to be generally parallel to the longitudinal axis of a wear member such as an adaptor. The wear member is thus cantilevered on the nose whereby the rotational moment is resisted by the high load forces applied to the upper

forward bearing face and the lower rear bearing face. Generally speaking the higher those load forces, the higher the friction available to hold the adaptor or wear member onto the nose. Because the bearing faces are substantially parallel, an adaptor cannot rotate off its nose.

The excavator tooth system according to the invention in effect becomes self-locking by virtue of its high internal frictional forces. As a consequence, the role of the retaining pin is substantially reduced from being a major structural component in prior art systems to being a device which simply stops the wear member from falling off a nose.

FIG. 2 shows an exploded view of an excavator tooth assembly according to one aspect of the invention.

As shown, the assembly comprises a mounting nose 1 (shown partially), an adaptor 12 and a replaceable digging point 13.

Adaptor 12 includes a hollow recess or socket (not shown) to receive the nose 1. Adaptor 12 is retained on nose 1 by a spool and wedge pin 14 which extends through oval-shaped apertures 15 in the adaptor body when aligned with aperture 11 in nose 1. Point 13 is releasably retained on the front tip of adaptor 12 by a retaining pin (not shown) extending through aligned apertures 16,17 in the point 13 and adaptor 12 respectively.

FIG. 3 is a schematic vertical cross-sectional view through the nose 1 and adaptor 12 of FIG. 2 and shows the engagement of the bearing surfaces of the nose and adaptor.

When the spool and wedge pin 14 is tensioned nose 1 is firmly located in the socket cavity 18 of adaptor 12 with the front bearing face 10 of

nose 1 in abutment with corresponding bearing face 10a in adaptor 12. Similarly, rear and forward bearing faces 7 and 8 are abutted against corresponding bearing faces 7a,8a respectively in adaptor 12.

FIG. 4 is a partial schematic transverse cross-sectional view through the nose/adaptor combination shown in FIG. 3.

As shown, spool and wedge retaining pin 14 is in an extended unlocked position with the shoulders 20 of pin body 21 being located behind the rear inner edges of apertures 15. A threaded bolt 22 is rotatably journalled in one end of pin body 21 and its other end is engaged in a threaded aperture 23 in wedge member 24. As bolt 22 is rotated, it draws wedge member 24 into the aligned apertures 15,11 of adaptor 12 and nose 1 respectively until it wedges adaptor 12 into tight engagement with nose 1 as shown in FIG. 5.

As can be seen in FIG. 5, retaining pin 14 is in a retracted locking position with the free ends thereof slightly recessed into apertures 15.

FIG. 6 shows a schematic transverse cross-sectional view through the assembly of FIG. 2 when in an assembled state.

FIG. 7 shows another aspect of the invention.

Depicted is a cutting lip 30 of an excavation device such as a dragline bucket (not shown).

Cutting lip 30 is cast as an integral component from a suitably wear resistant metal alloy and comprises a transverse cutting bar 31, cheek plates 32 and mounting noses 1 at spaced intervals therealong.

Noses 1 are faired back into cutting bar 31 forming recessed

regions 33 between adjacent noses. At the front portion of each cheek plate 32 are mounts 34 for attachment of replaceable cutting edges (not shown).

FIGS. 8 and 9 respectively show an exploded view and an assembled view of the cutting lip 30 of FIG. 7 with adaptors 12 and digging points 13 of FIG. 2.

In the assembly of FIG. 9, lip shrouds 35 are removably secured in the recessed regions of bar 31 to minimize wear on the lip assembly. As can be seen from FIG. 9 and also from FIGS. 1 and 3, the aligned pin apertures 11,15 of nose 1 and adaptor 12 respectively are displaced vertically upward relative to a transverse plane occupied by the longitudinal axis X as shown in FIG. 1, which axis lies in a central plane of nose 1. By having the mounting apertures offset from a central position, the retaining pins can be removed or installed without needing to remove the lip shrouds 35. In turn, this permits the face of the lip shroud 35 to be located at its optimal position with the face of the shroud running along the centre line of the tooth assembly.

It readily will be apparent to persons skilled in the art that many variations and modifications may be made to the invention without departing from the spirit and scope of the invention.

For example, as the key digging forces are taken up by the socket and spigot fitting between the nose and the wear member or adaptor; the retaining pin can be of any design as it functions merely to hold the wear member in place on the nose and otherwise does not constitute a load bearing member.

FIG 10 shows lock 36 being an alternative embodiment of a locking pin.

FIG 11 shows a longitudinal cross sectional view of the retaining member 38 illustrated in FIG 10.

FIG 12 shows a longitudinal cross sectional view of the body member 37 of FIG 10.

As shown in FIGs 10 to 12 the locking pin 36 comprises a body member 37 wherein the body has an oval shaped cross section of substantially identical configuration as the cross sectional shape of aperture 11 in mounting nose 1 as illustrated in FIG 3. As can be seen in FIG 10, the centre of screw threaded aperture 45 is displaced from the intersection of the longer and shorter axis of the oval shaped cross section of body member 37. However, the centre of screw threaded shaft remains on the longer axis, the reason for which will be discussed in detail below.

In use, both of retaining members 38 are withdrawn from each screw threaded aperture 45 of body member 37 independently of mounting nose 1. Body member 37 is fully inserted into aperture 11 on mounting nose 1 of an excavator bucket as shown in FIG 3, FIG 4 and FIG 5. Adaptor 12 is then located on mounting nose 1. As seen in these figures, aperture 15 on adaptor 12 is partially misaligned with aperture 11 on mounting nose 1 when adaptor 12 is located on mounting nose 1. This partial misalignment captively retains body member 37 within aperture 11 while mounting nose 1 is located on adaptor 12. Furthermore, body member 37 is prevented from rotating within aperture 11 due to the oval shaped cross section of body

member 37 being complementary with oval shaped aperture 11.

Referring specifically to FIG 4 and FIG 5, even though body member 37 is captively retained within aperture 11 due to the misalignment of aperture 11 and aperture 15, screw threaded aperture 45 of body member 37 is still not covered by adaptor 12 and hence remains accessible. This is due to screw threaded aperture being offset from the centre of body member 37 as described above.

To retain adaptor 12 on mounting nose 1, retaining members 38 are inserted through apertures 15 and 11 at opposite ends of body member 37 such that the screw threaded shaft 41 of each retaining member is coupled with the screw threaded aperture 45 at either end of the body member 37. When tapered shoulder portion 40 abuts tapered recess 44, at least some of head portion 39 is located within aperture 15 on either side of adaptor 12. This protrusion of the head portion 39 at either end of lock 36 prevents adaptor 12 from sliding off mounting nose 1. As discussed above, lock 36 may be used with only a single retaining member 38 to retain adaptor 12 on mounting nose 1.

To remove adaptor 12 from mounting nose 1 retaining members 38 are decoupled from body member 37. This is facilitated by removing screw threaded shaft 41 of each retaining member 38 from screw threaded aperture 45 at either end of body member 37. Adaptor 12 can then be removed from mounting nose 1 as head portion 39 of each retaining member 38 no longer retains the adaptor on the mounting nose. Once adaptor 12 has been removed, body member 37 can be extracted from

aperture 11.

Lock 36 is self-locking and self-aligning due to the abutment of tapered shoulder portion 40 with tapered recess 44. This tapered contact provides for greater frictional gripping between body member 37 and retaining member 38 than a conventional square shouldered contact. A person skilled in the art will recognise the analogy between the tapered contact made between retaining member 38 and body member 37 and the configuration of a wheel nut. Hence, retaining member 38 remains in secure contact with body member 37 while in use and retains adaptor 12 on nose 1. When it is necessary to remove adaptor 12 from nose 1 the tapered contact provides for an easy release of retaining member 38 from body member 37 thus reducing the time necessary to change the adaptor leading to increased efficiency.

Furthermore, the tapered contact accounts for manufacturing tolerances of member 37 and retaining member 38 as the lock is self-aligning when tapered shoulder portion 40 proceeds into tapered recess 44, and the retaining member is tightened, the tapered contact guides retaining member 38 and body member 37 into alignment.

The tapered contact also prevents the passage of water within screw threaded aperture 45 and hence reduces the risk of corrosion of lock 36 although, preferably, an anti-corrosive grease would still be applied to the components of lock 36 to ensure that no corrosion occurs.

The contact between tapered shoulder portion 40 and tapered recess 44 also allows for the efficient transfer of any load on head portion 39

to body member 37 rather than to the thread of screw threaded shaft 41. Hence, the only means by which lock 36 may fail is if head portion 39 is sheared from screw threaded shaft 41 and it is envisaged that such a force will not be encountered in normal operation.

Lock 36 provides for an elegantly simple system for releasably retaining a wear member to a mounting nose of an excavator bucket. The lock is relatively cheap to manufacture and is easy to use in the field while still providing a secure attachment means.

While resilient plugs may be employed to plug the locking pin apertures of FIGs 2 to 6 to stop ingress of particulate matter which might otherwise constitute an abrasive material, entry of dirt into the small spaces between the flat faces of the socket and spigot members of the assembly tend to pack tightly and actually prevent relative movement between the nose and the wear member thus reducing, rather than increasing, internal wear between components.

Throughout this specification, unless the context requires otherwise, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers or steps but not the exclusion of any other integer or group of integers.

DATED this 15th day of April 2002.

THOMAS ANTHONY MEYERS

by his Patent Attorneys

FISHER ADAMS KELLY

FIG 1

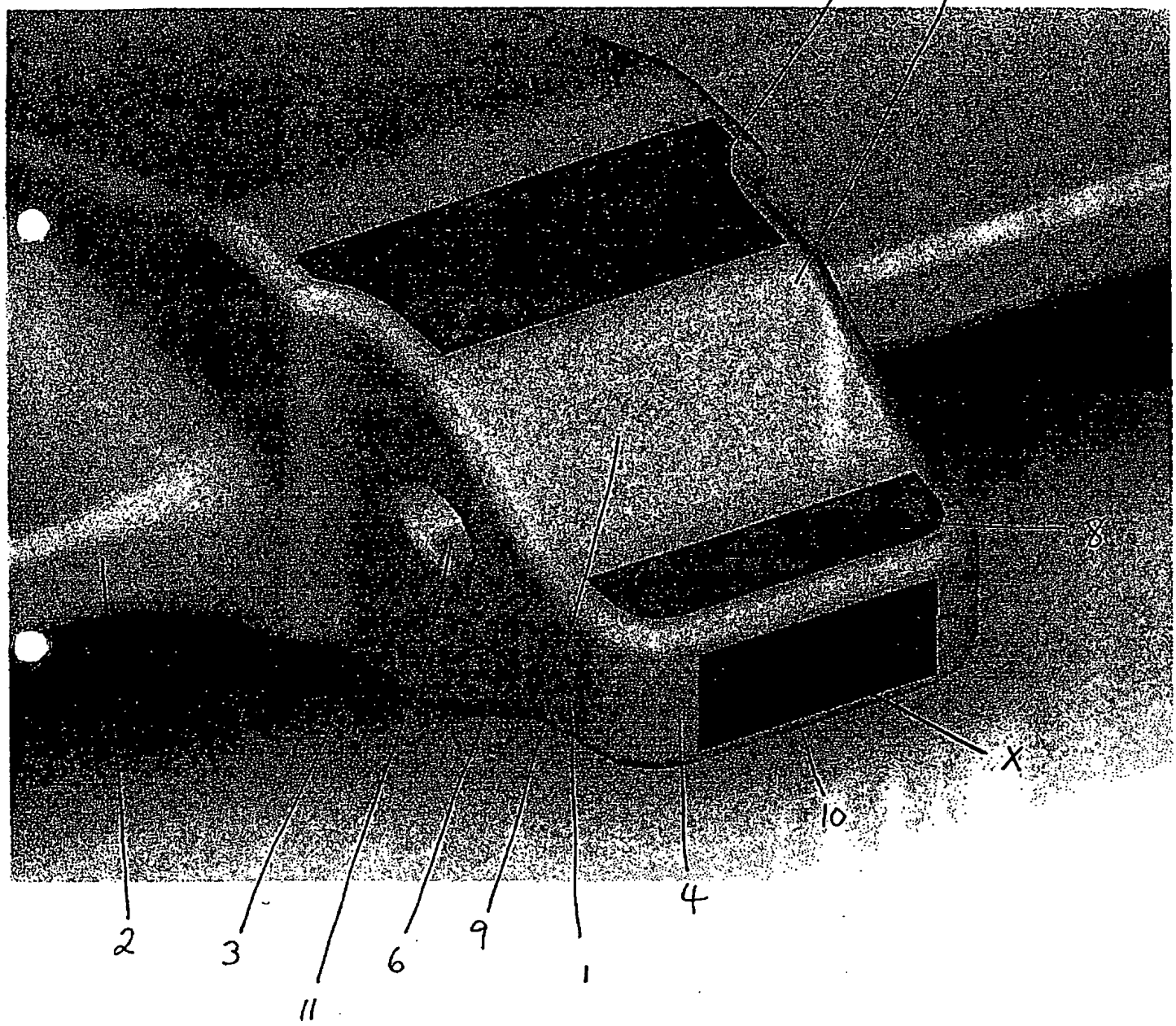


FIG 2

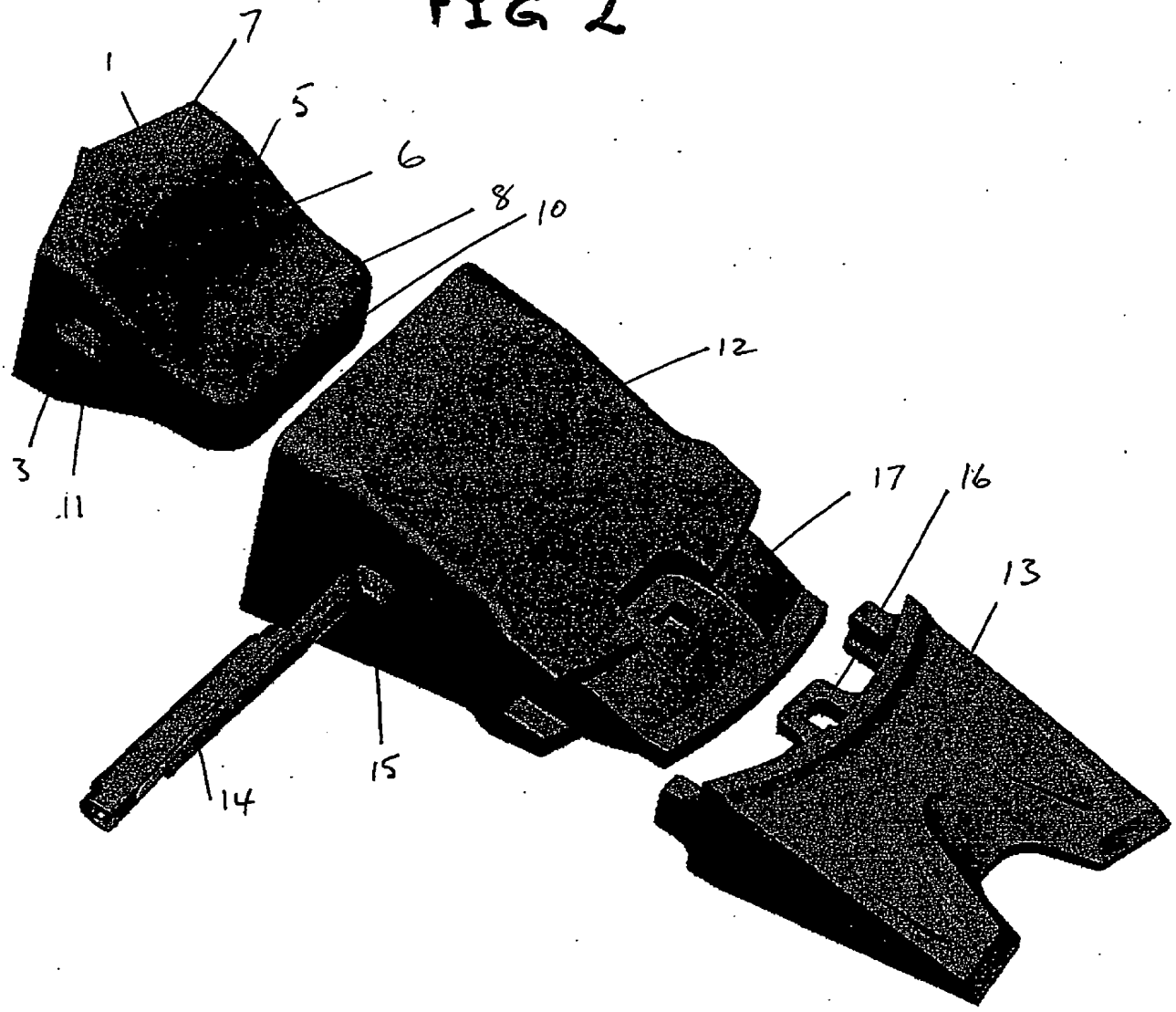


FIG 3

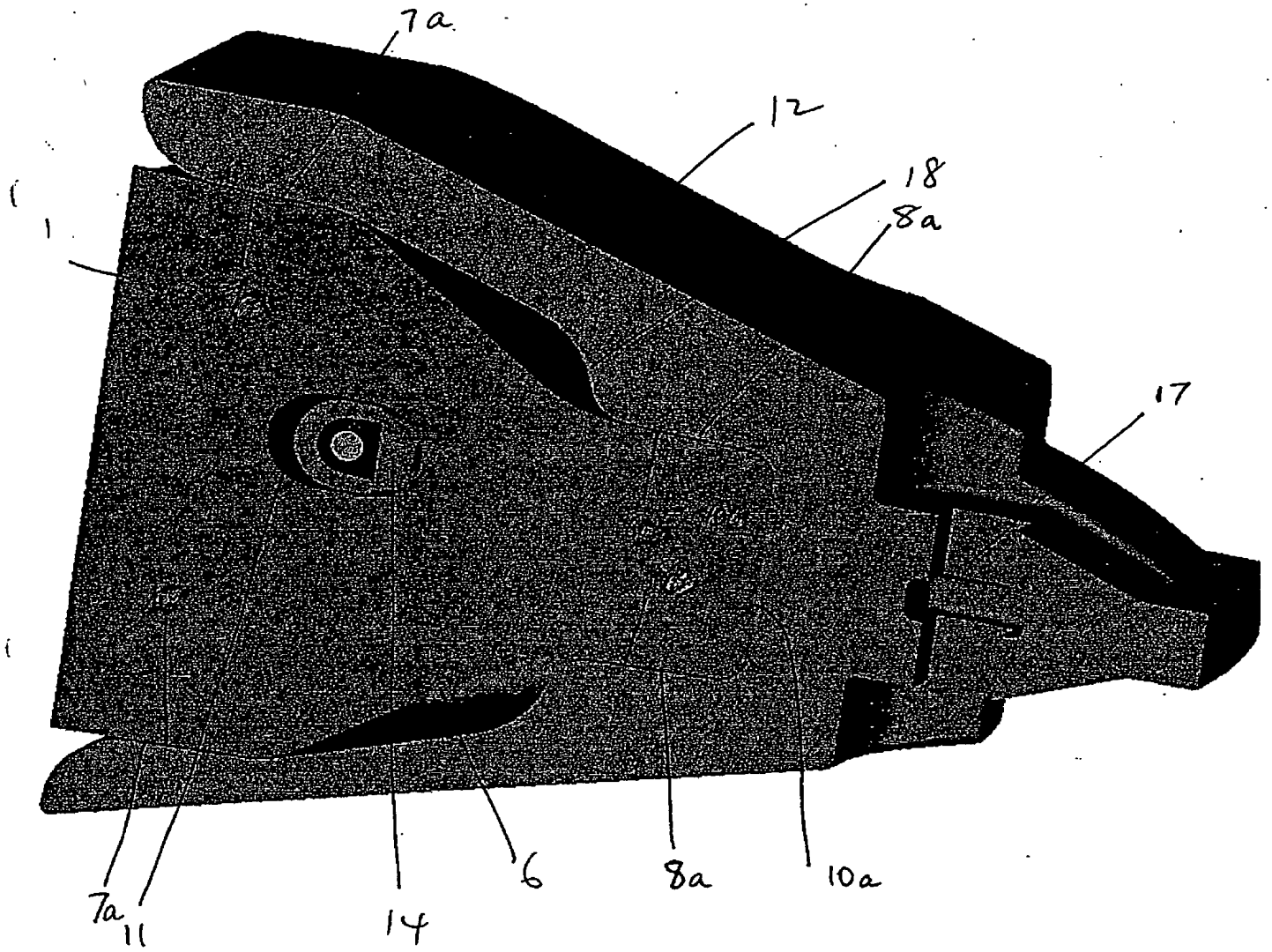


FIG 4

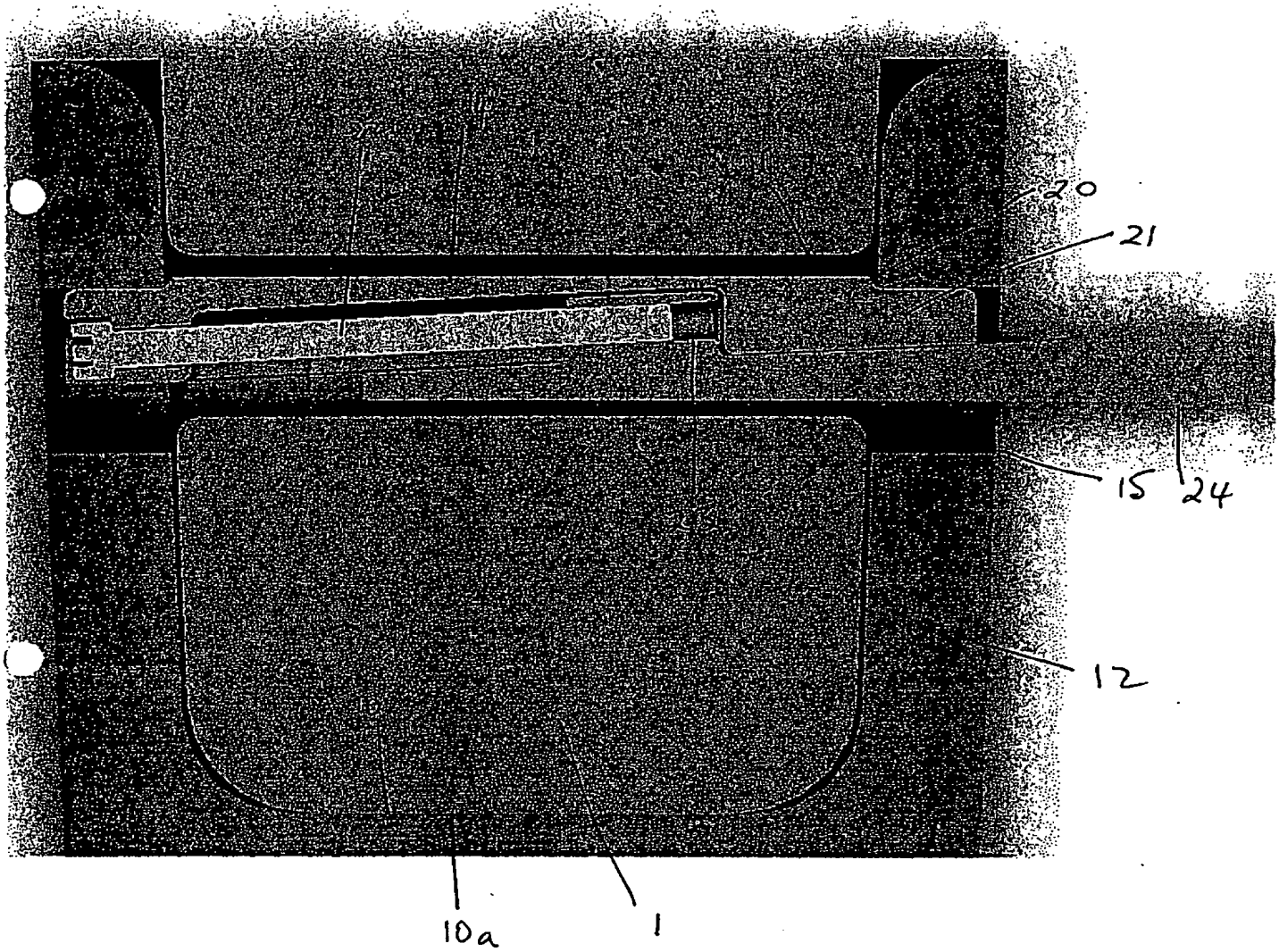


FIG 5

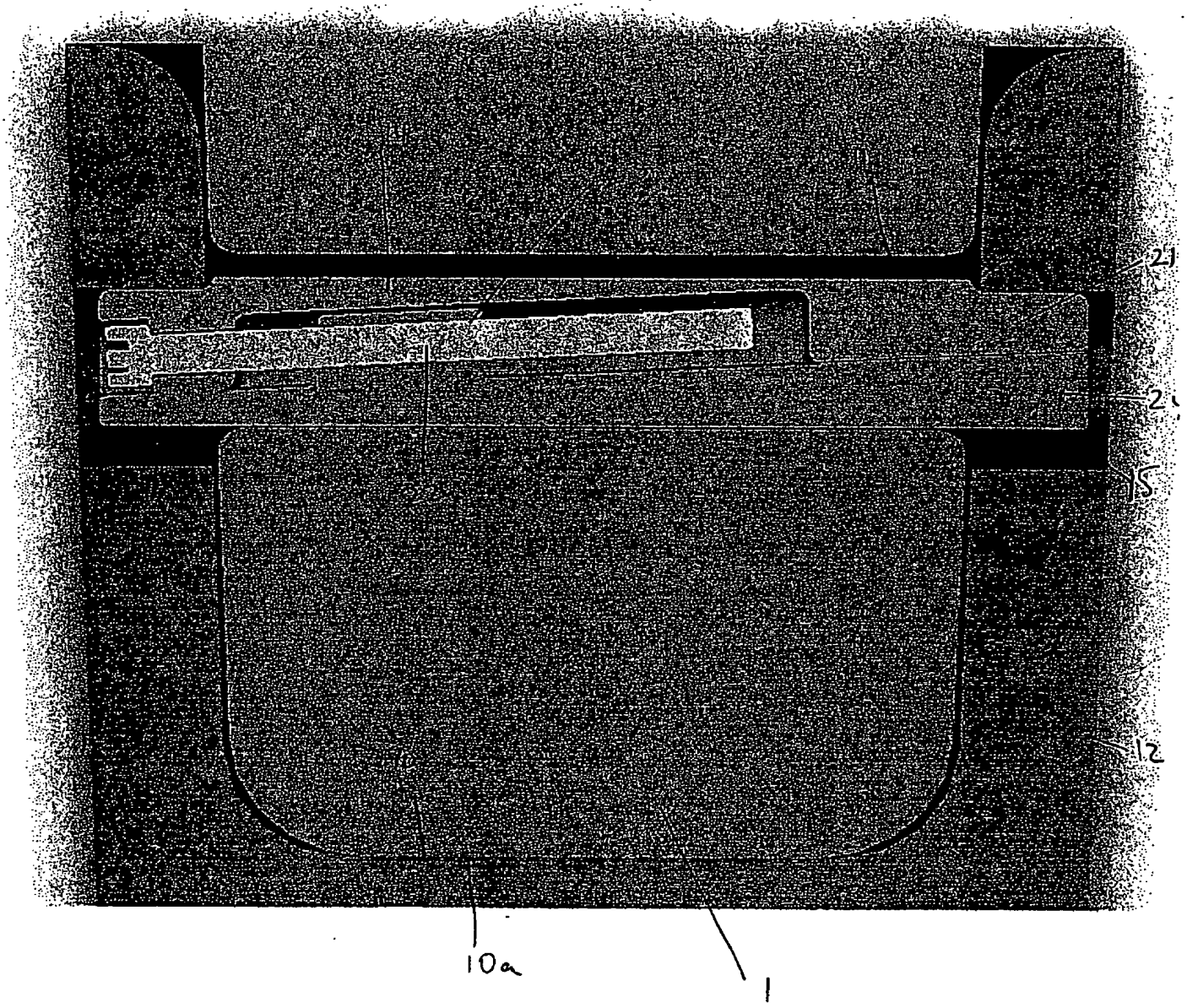


FIG 6

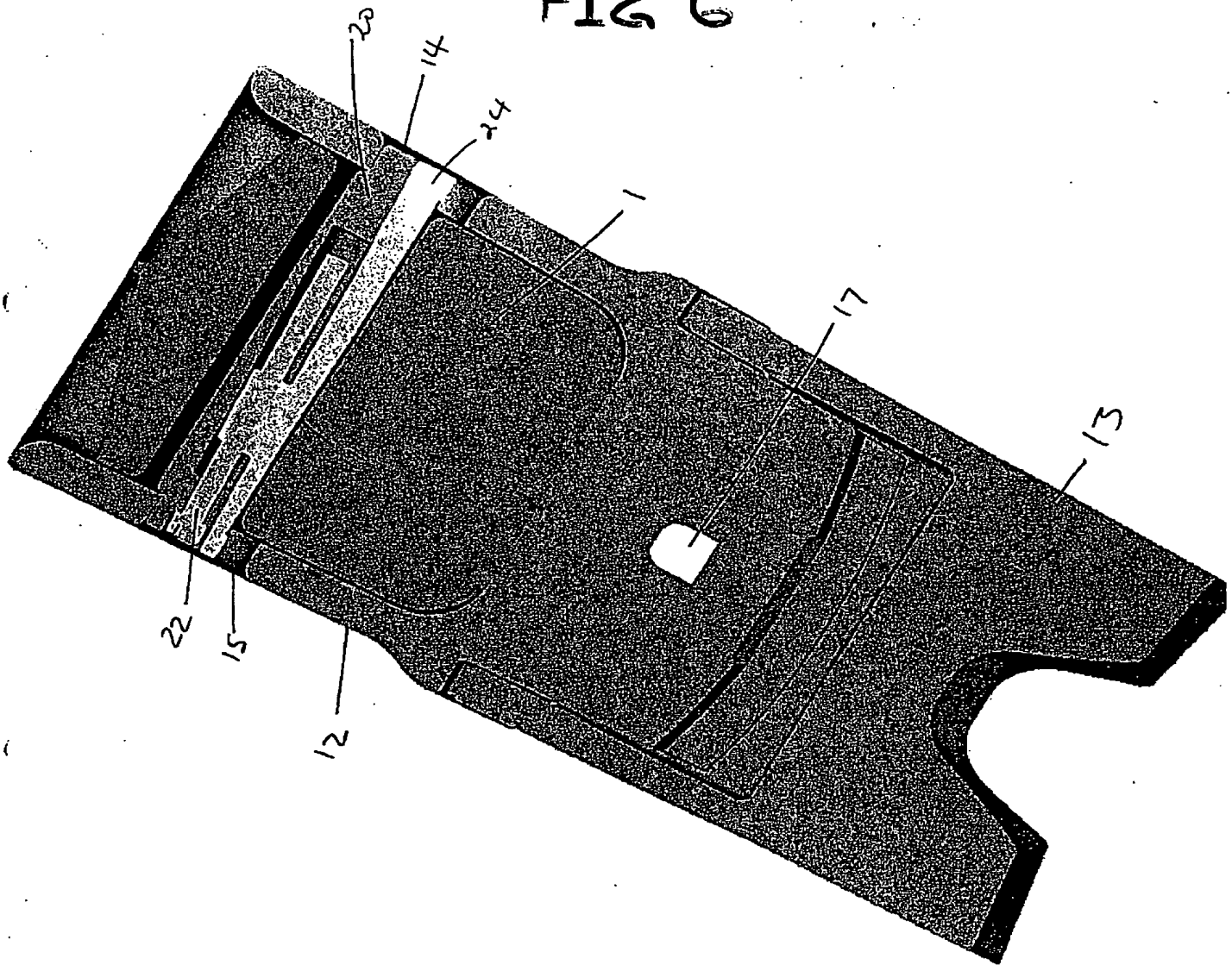


FIG 7

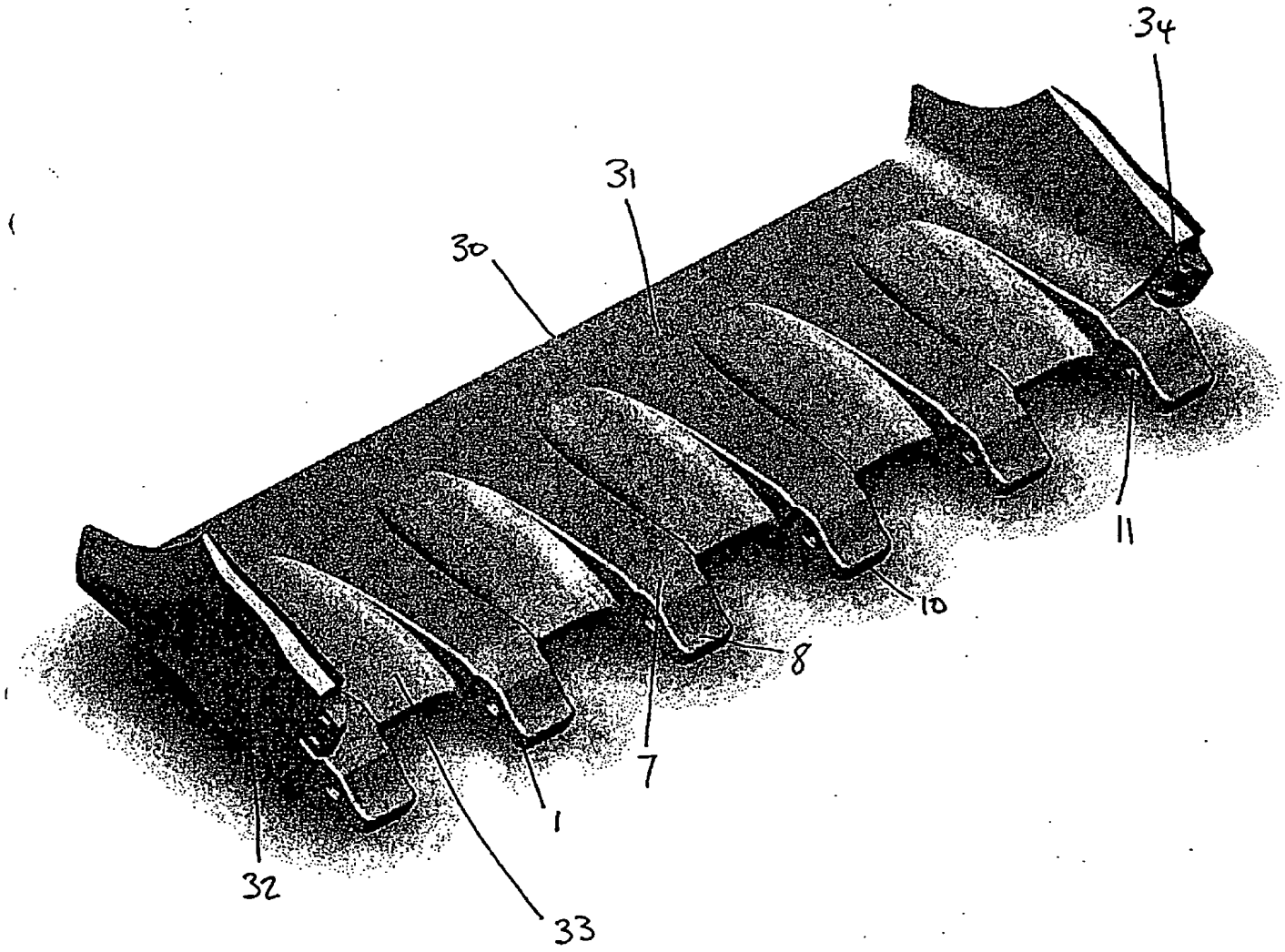


FIG 8

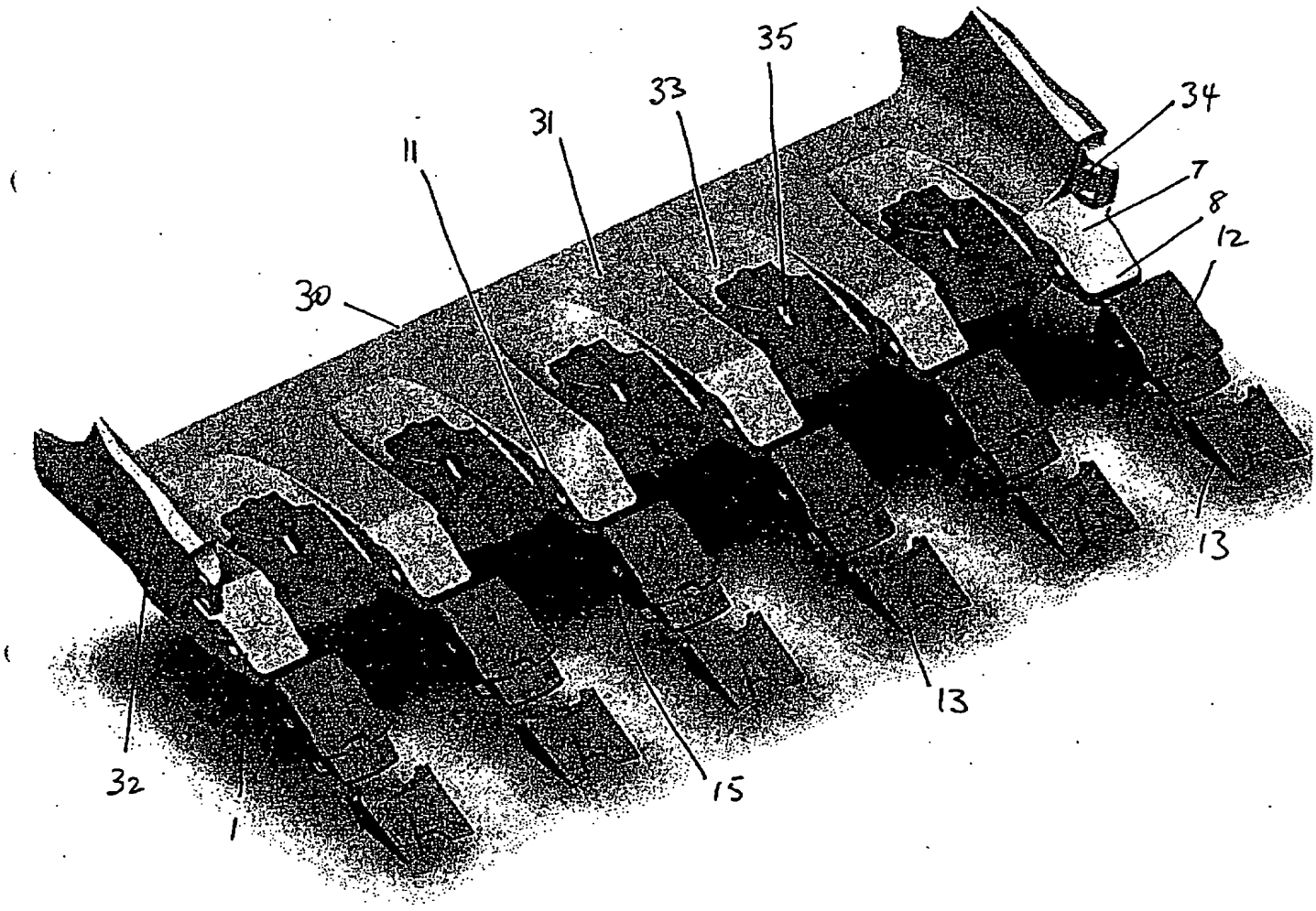
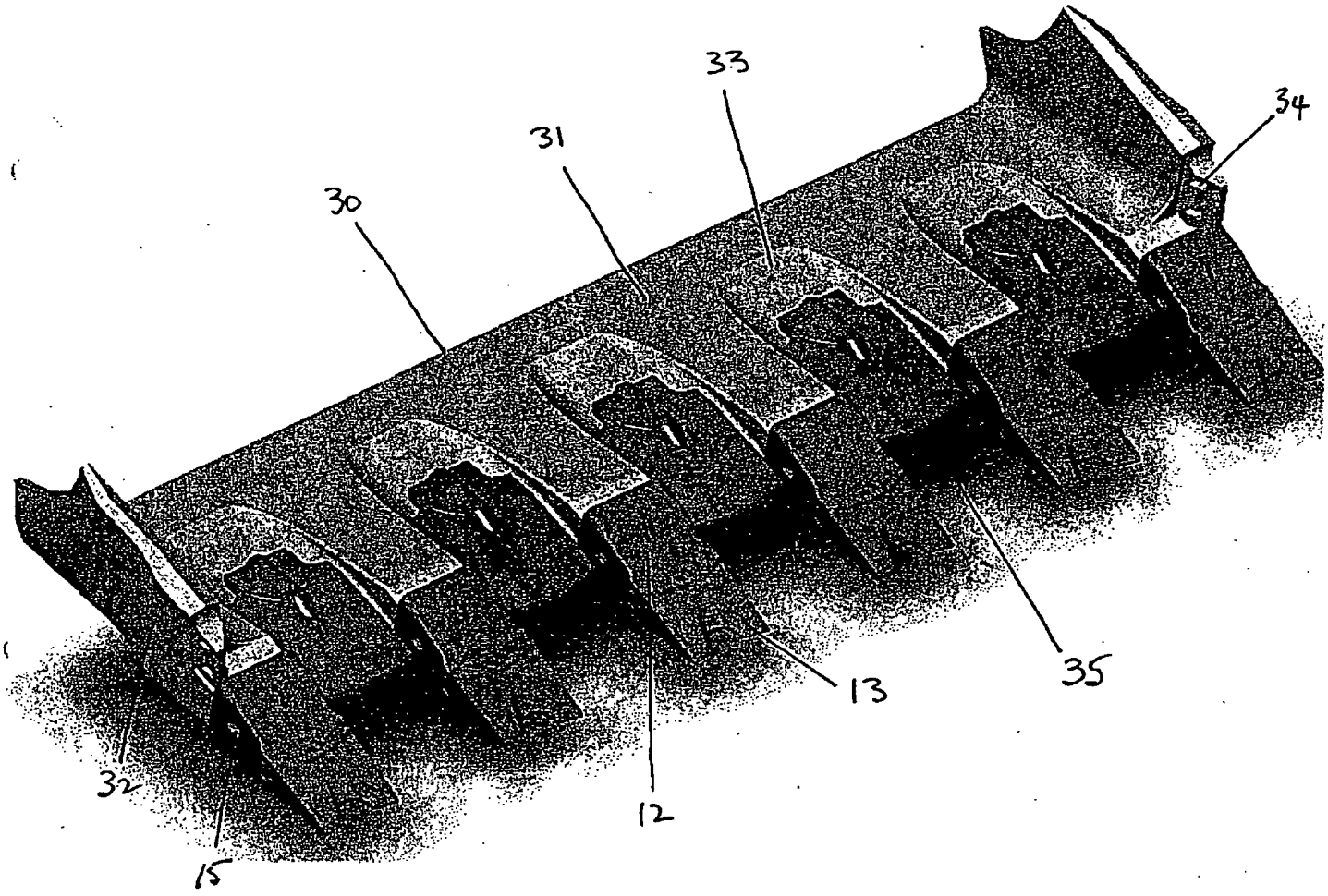


FIG 9



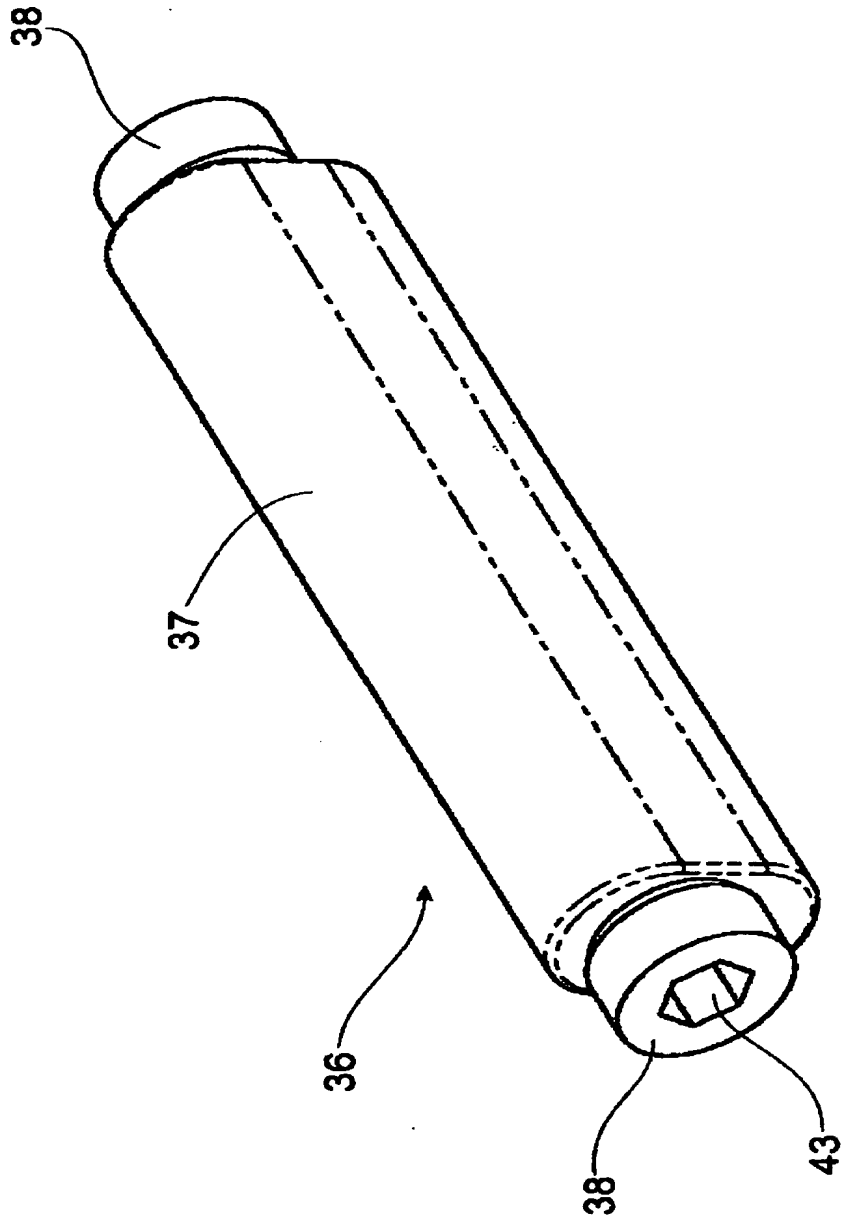


FIG. 10

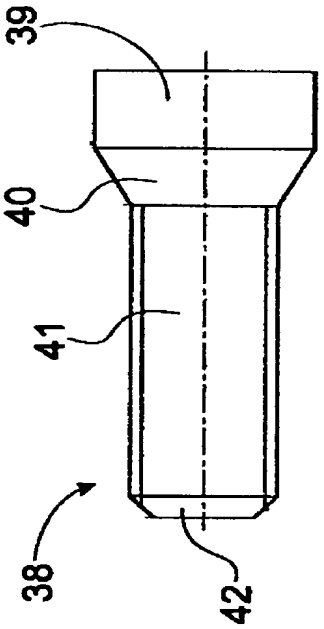


FIG. 11

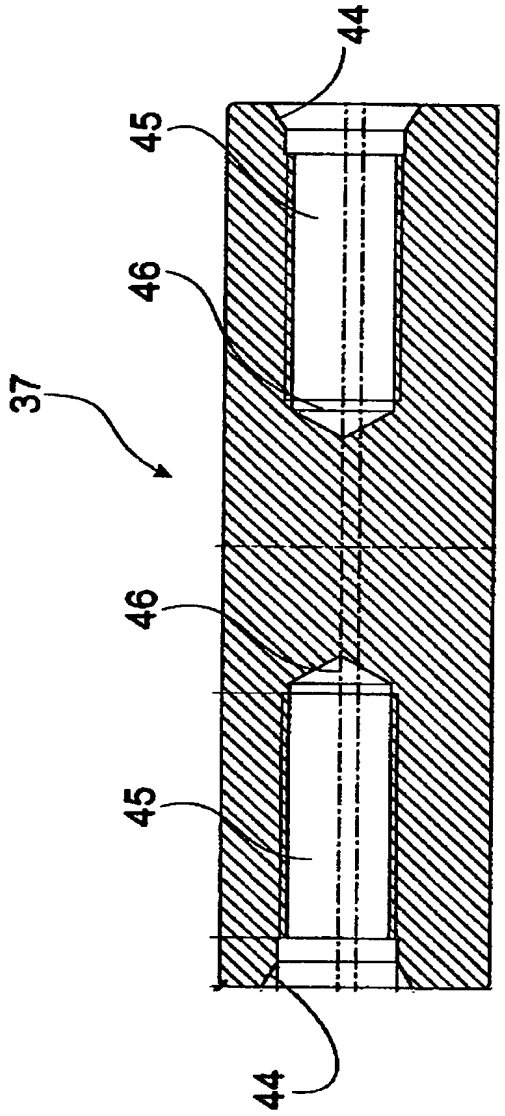


FIG. 12